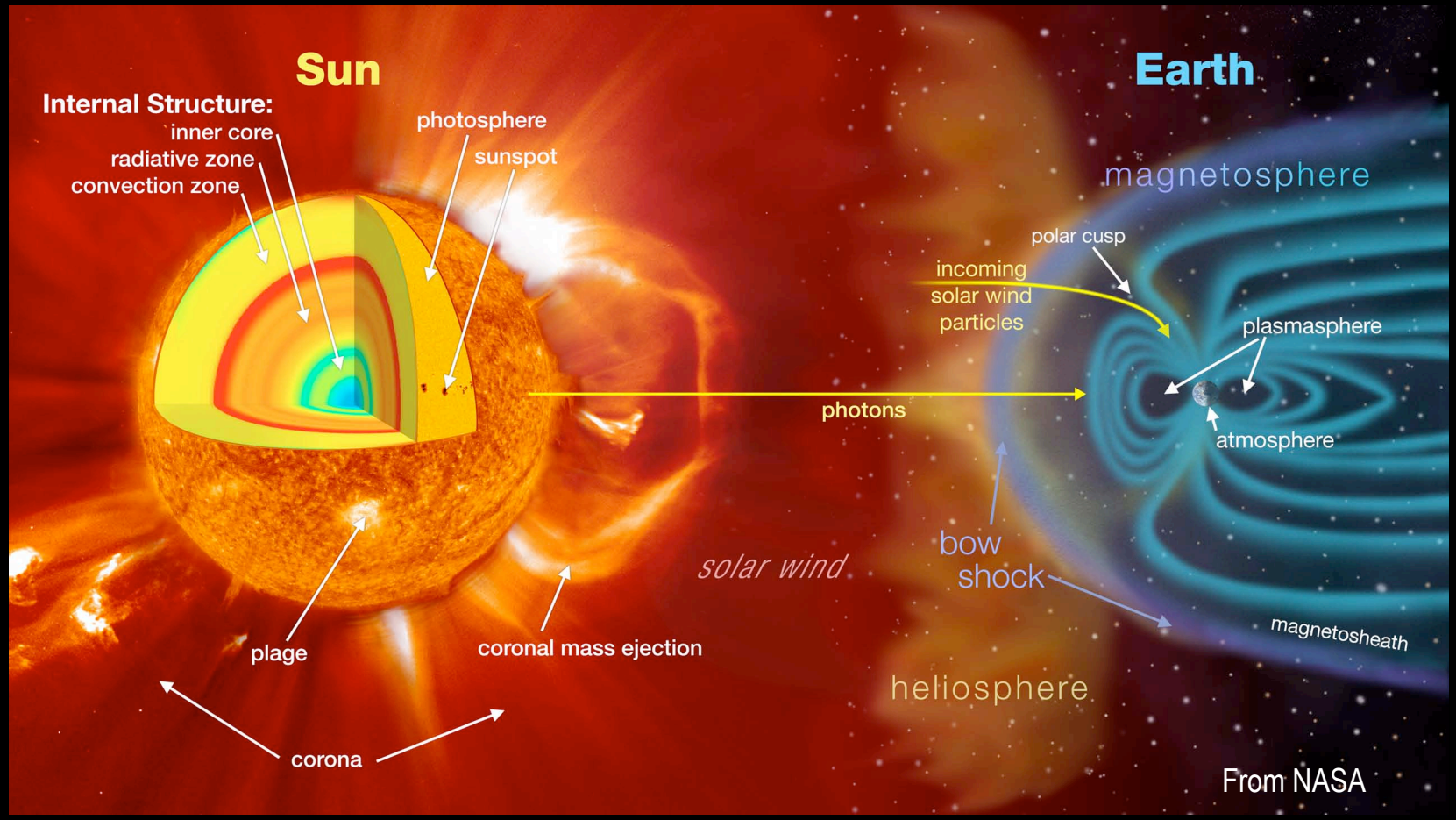
Interaction between solar wind and geo-magnetosphere

Space weather & Space climate

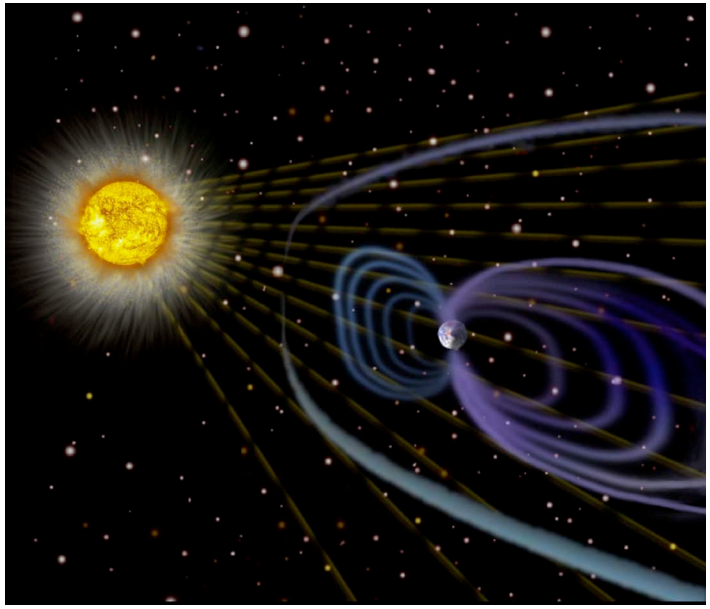
Sun–Earth system



Space weather

(short-term variation)

*Solar winds carry **charged particles** and **magnetic fields** to the Earth, which have **collisional** and **electromagnetic** effects on terrestrial environment.*



high-energy particle => collisional effect on objects around the Earth

magnetic field => electromagnetic effect on the magnetic structure of the Earth

bulk flow => momentum effect on the objects and magnetic structure

Basic structure of magnetosphere

Magnetosphere and its boundary (magnetopause)

Solar wind plasma **does not cross terrestrial magnetic field** => **distinct space for terrestrial plasma** is formed around the Earth (**magnetosphere**), which is separated from **interplanetary space** by **magnetopause**.

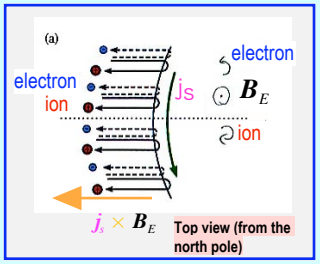
Front side of the magnetosphere

Terrestrial magnetic field is compressed by solar wind.

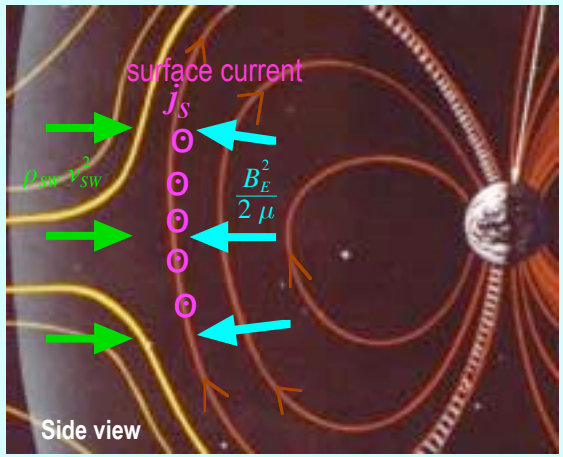
Pressure balance

Solar wind bulk pressure ~ **Terrestrial magnetic pressure**

$\rho_{SW} v_{SW}^2$ $\quad$ $\frac{B_E^2}{2\mu}$



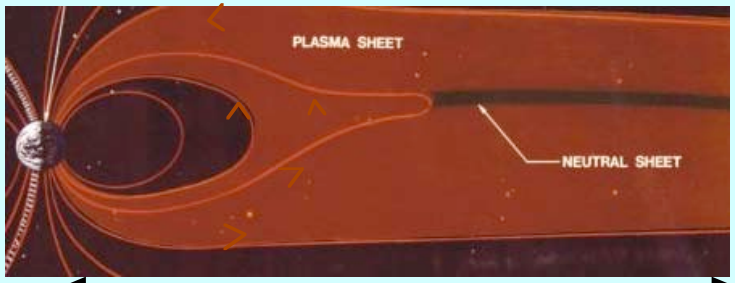
Chapman & Ferraro



≤ 10 R_E

Back side of the magnetosphere

Terrestrial magnetic field is elongated by solar wind.
=> forms "**magnetotail**"



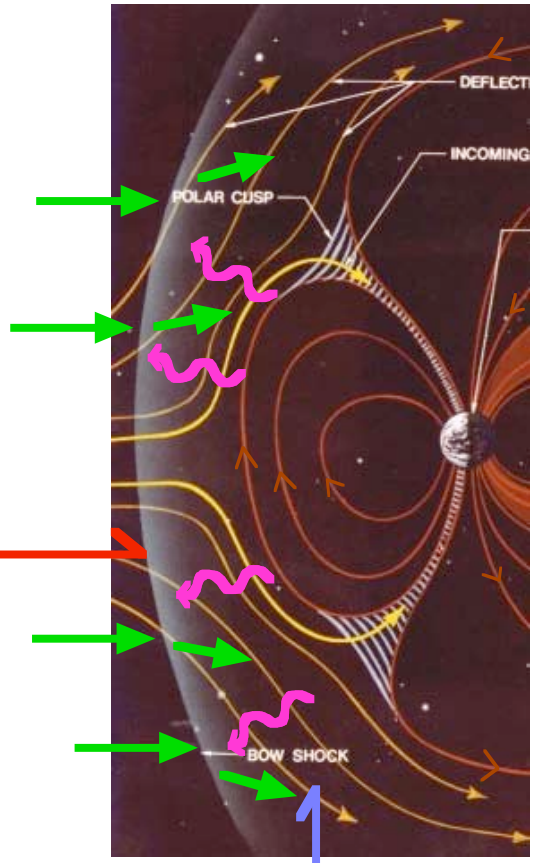
≥ 200 R_E

Bow shock

Solar wind... **super-magnetoacoustic flow**

speed of magnetoacoustic wave... v_{ma} = 100 km/s

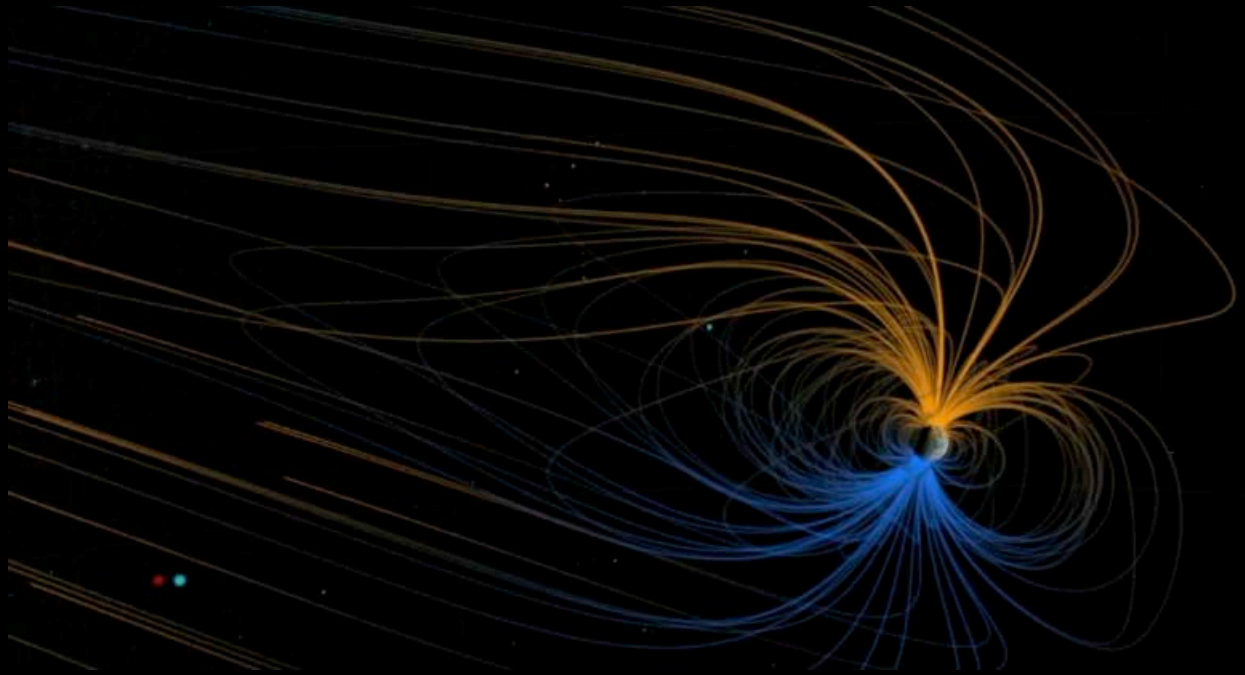
speed of (slow) solar wind... v_{sw} = 450 km/s



$v_{SW} > v_{ma}$ => **shock wave (bow shock)** is formed

Magnetosheath... region between **bow shock** and **magnetopause**
sub-magnetoacoustic flow, enhanced density & temperature

3D magnetic field configuration in magnetosphere



https://www.youtube.com/watch?v=k67OGI-ur3I

Magnetospheric current system (steady state)

magnetosphere

magnetosphere-ionosphere current system

Because the magnetopause boundary separates a region of relatively strong magnetic field (the magnetosphere) from a region of relatively weak magnetic field (the magnetosheath), the boundary must carry a surface current to ensure force balance across the boundary. This magnetopause current flows differently on the day side and night side of the Earth.

The ***magnetopause current*** encircling the magnetotail lobes closes through the middle of the tail in a ***neutral sheet current*** that separates the oppositely directed magnetic fields in the two tail lobes.